

Mechanical Technical Assignment 1

ASHRAE Standard 62.1 Compliance Evaluation

ASHRAE Standard 90.1 Compliance Evaluation

UNLV Greenspun Hall
Las Vegas, Nevada

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Table of Contents

Executive Summary.....	2
System and Equipment Compliance.....	4
System Selection.....	6
Procedure.....	7
Sample Calculation.....	8
Ventilation Rate Compliance.....	10
ASHRAE Standard 90.1-2007 Compliance.....	12
Appendix A.....	15

Executive Summary

This report contains the evaluation of UNLV's Greenspun Hall in accordance to ASHRAE Standard 90.1-2007 and sections 5 and 6 of ASHRAE Standard 62.1-2007. The building is mainly comprised of classroom and office space with some multi-media and auditorium areas.

The mechanical system is comprised of six air-handling units and two centrifugal chillers distributed to the zones through various constant volume boxes, variable volume boxes, and chilled beams. Numerous fan coil units are located throughout the building, which are 100% recirculated air, to assist with the building's cooling load.

After review, Greenspun Hall was determined to be compliant with section 5 of Standard 62.1. A variety of ventilation problems became apparent through calculation. All of these are located in non-critical spaces and can be attributed to varying occupancy density assumptions. The overall result is that Greenspun Hall is in compliance with ASHRAE Standard 62.1 Section 6.

No major discrepancies were found in examining Standard 90.1. Greenspun Hall was designed to be an efficient building in all facets, although it did not comply completely with the standard. Amongst that which did not meet requirements were chiller efficiency and lighting requirements. Minimum lighting requirements is attributed to the amount of natural lighting supplied by the design of the building.

Part I

ASHRAE Standard 62.1

Section 5 Analysis

Systems and Equipment Compliance

Due to the location and setting of the building and the recurring nature of its HVAC system, many provisions set forth in ANSI/ASHRAE Standard 62.1-2007 are either not applicable or fundamental to the system. Therefore, a short directory of significant compliances with Section 5 is written below.

5.3.1 Exhaust Duct Location

All exhaust ducts within the structure are designed at negative pressure and most lead to three main mechanical shafts, with East, North East, and West locations, which are connected to exhaust fans on the roofs.

5.5.1 Resistance to Mold Growth

All surface materials specified in the construction documents are determined to be resistant to mold growth through standardized testing methods.

5.6.1 Outdoor Air Intakes Location

The outdoor air intake for AHU-1 is located above a loading dock meeting the 25 ft. separation requirement. All other outdoor intakes for the air-handlers are located on the roofs in excess of the minimum distances listed in table 5-1 from the exhaust fans, meeting code requirements. Other miscellaneous exhaust fans are located off of the roof far from outdoor air intakes.

5.9 Particulate Matter Removal

All filters provided in the system are specified at MERV-13, exceeding the code requirement of MERV-6.

5.14 Access for Inspection, Cleaning, and Maintenance

Equipment layouts provide unobstructed access to all components of the system. All air-handling units are located on the mechanical mezzanine or the rooftop. Fan coils and terminal boxes are located in dropped ceilings or other ceiling cavities with provided panel access.

5.15 Building Envelope and Interior Surfaces

Architectural details confirm that all exterior surfaces are designed to avoid moisture permeation into the building envelope. All pipes and ductwork were provided with a sufficient amount of exterior insulation.

Part II

ASHRAE Standard 62.1

Section 6 Analysis

System Selection

All systems were selected for analysis for this project. All zones requiring outdoor air are supplied via constant volume boxes, variable volume boxes, or chilled beams which are served by six air-handling units. Fan coil units are also located in the building's mechanical system, although they only recirculate air within zones to handle the cooling load. AHU's 1 & 2 provide a mixture of recirculation air and outdoor air and provide air only to zones on the ground level, where as AHU's 3, 4, 5, and 6 are 100% outdoor air and supply office space zones on the ground level and the remainder of zones on all other levels.

The building is a mixed-use facility including classrooms, multi-media spaces, office space, and an auditorium, primarily comprised of office space. Therefore, the assumption was made that all areas not specifically noted or described as a classroom, laboratory, auditorium, media center, conference room, or reception area was assumed to be classified as general office occupancy category. A complete breakdown of actual zone occupancy was not known, therefore calculations were based upon default values of occupant density and combined outdoor air rate. The only exceptions being corridors and general storage which don't have an occupant density and are based off of an area rate of 0.06 cfm/ft² and 0.12 cfm/ft² respectfully.

Please refer to Appendix A for a more detailed system analysis.

Procedure

After determining all occupancy categories and zone floor areas, this procedure can be followed to determine the outdoor air intake flow rate (V_{ot})

Step 1 Determine Breathing Zone Outdoor Airflow (V_{bz})

$$V_{bz} = (\text{DefaultOccupantDensity})(\text{Area})(\text{CombinedOutdoorAirRate})$$

Step 2 Determine Zone Outdoor Airflow (V_{oz})

The value E_z is determined to be 1.0 for all calculations.

$$V_{oz} = V_{bz} / E_z \quad (6-2)$$

Step 3 Calculate Primary Outdoor Air Fraction (Z_p)

$$Z_p = V_{oz} / V_{pz} \quad (6-5)$$

Step 4 Determine System Ventilation Efficiency (E_v)

Table 6-3 or calculated based on ASHRAE Standard 62.1 Appendix A

Step 5 Calculate Uncorrected Outdoor Air Intake (V_{ou})

The value of occupant diversity (D) was determined to be 1.0 for a conservative result.

$$V_{ou} = D \sum_{\text{allzones}} (R_p P_z) + \sum_{\text{allzones}} (R_a A_z) \quad (6-6)$$

Step 6 Calculate Outdoor Air Intake (V_{ot})

$$V_{ot} = V_{ou} / E_v \quad (6-8)$$

Sample Calculation

From Room 1232-Music Library served by AHU-2

Step 1 Determine Breathing Zone Outdoor Airflow (V_{bz})

$$V_{bz} = \left(\frac{5 \text{ people}}{1,000 \text{ ft}^2} \right) \left(\frac{400 \text{ ft}^2}{1} \right) \left(\frac{17 \text{ cfm}}{\text{person}} \right) = 34 \text{ cfm}$$

Step 2 Determine Zone Outdoor Airflow (V_{oz})

$$V_{oz} = V_{bz} / 1 = 34 \text{ cfm}$$

Step 3 Calculate Primary Outdoor Air Fraction (Z_p)

$$Z_p = \left(\frac{34 \text{ cfm}}{40 \text{ cfm}} \right) = 0.85$$

Note: all Z_p values greater than 1 were omitted for this calculation.

* This occurs in certain zones due to occupancy assumptions and/or design codes used other than ASHRAE Standard 62.1.

Step 4 Determine System Ventilation Efficiency (E_v)

$$Z_p > 0.55$$

$$E_{vz} = \min E_v = (F_a + X_s F_b - Z_d F_c) / F_a$$

$$F_a = E_p + (1 - E_p) E_r \quad E_p = 1$$

$$F_a = 1 \quad F_b = E_p = 1$$

$$F_c = 1 - (1 - E_z)(1 - E_r)(1 - E_p) \quad E_z = 1$$

$$F_c = 1$$

$$X_s = \frac{V_{ou}}{V_{ps}} = \frac{34}{17,000}$$

$$Z_d = \frac{V_{oz}}{V_{dz}} = \frac{34}{40}$$

$$E_v = \left[1 + \left(\frac{34}{17,000} \right) 1 - \left(\frac{34}{40} \right) 1 \right] / 1 = 0.152$$

Step 5 Calculate Uncorrected Outdoor Air Intake (V_{ou})

$$V_{ou} = \sum V_{oz} = 3,030cfm$$

Step 6 Calculate Outdoor Air Intake (V_{ot})

$$V_{ot} = \frac{V_{oz}}{E_v} = \frac{3,030}{0.152} = 19,935cfm$$

Ventilation Rate Compliance

Generally, UNLV's Greenspun Hall displays compliance with ASHRAE Standard 62.1-2007 Section 6. Most zones were supplied ample outdoor air ventilation in accordance with the code. Problem areas were found in zones served by AHU-1 and AHU-2 but are located in non-critical spaces and can be attributed to occupancy density assumptions. Tables located in Appendix A portray the calculation in detail. A summary of the ventilation rate from each air-handling unit is described in the table below.

	Outdoor Air Ventilation		
	Actual	Calculated	%Difference
AHU-1	10,200	19,935	195.44%
AHU-2	3,600	2,875	79.86%
AHU-3	7,000	3,305	47.21%
AHU-4	8,200	2,365	28.84%
AHU-5	5,100	1,500	29.41%

Part III

ASHRAE Standard 90.1

Analysis

Building Envelope

ASHRAE Standard 90.1-2007 Section 5 sets forth minimum requirements for the building envelope. UNLV's Greenspun Hall falls under the space-conditioning category of 'non-residential conditioned space' and fulfills the constraints to be analyzed under the prescriptive building envelope method.

Location: Las Vegas, Nevada
Climate Zone: 3B

The two requirements for the building envelope in climate zone 3B are opaque elements and fenestration. Opaque elements include floors, walls, opaque doors, and roofs. Fenestration includes vertical glazing and skylighting. The following tables describe compliance with the standard.

Element	Description	Min. R Value	Design R Value	Compliance
Roofs	Insulation Entirely Above Deck	R-20.0 c.i.	27.4	Yes
Walls, above grade	Mass	R-7.6 c.i.	14.7	Yes

table-1a

Fenestration	Description	Max. U Value	Design U Value	Compliance
Vertical Glazing 0-40% of wall	Metal framing	U-0.60	0.30	Yes

table-1b

Heating, Ventilation, and Air-Conditioning

ASHRAE Standard 90.1-2007 Section 6 describes minimum requirements for mechanical systems efficiencies. Since the building is greater than 2 stories, the simplified method for determining this cannot be used. Therefore, the analysis of Greenspun Hall's efficiencies was carried out through the mandatory provisions path. Various pieces equipment must be tested to comply with the minimum efficiencies described under standard operating conditions in 90.1. The results of these tests are shown in following tables.

Boiler	Output MBH	Min. Efficiency	Design Efficiency	Compliance
B-1	1,063	75% e_i	87%	Yes
B-2	1,063	75% e_i	87%	Yes

table-2a

Chiller	Min. COP	Min. NPLV ^c	Design COP	Design NPLV ^c	Compliance
CH-1	5.55	5.9	2.75	2.86	No
CH-2	5.55	5.9	2.75	2.86	No

table-2b

Service Water Heating

ASHRAE Standard 90.1-2007 Section 7 states the minimum requirements for water heating equipment. This was analyzed using the mandatory provisions path and the system's compliance with the standard was described table-2a above.

Power

ASHRAE Standard 90.1-2007 Section 8 provides requirements for power distribution systems in buildings. This can be evaluated by the mandatory provisions section of the code. Greenspun Hall is confirmed to be in compliance with the standard as it meets the requirements of maximum voltage drop for feeders as 2% and maximum voltage drop for branch circuits as 3% at design load.

Lighting

ASHRAE Standard 90.1-2007 Section 9 describes requirements for power density. The building area method was used to determine interior lighting power allowances for Greenspun Hall. The results of the comparison are shown in table-3.

Type	LPD (W/ft ²)	Design (W/ft ²)	Compliance
Office	1.0	1.1	Yes
University	1.2	1.1	No

table-3

Electric Motors

ASHRAE Standard 90.1-2007 Section 10 states requirements for electric motor efficiencies. This was determined via the mandatory provisions path which is summarized in table-4.

Motor	HP	BHP	RPM	Min. Efficiency	Design Efficiency	Compliance
AHU-1	40	30.1	1580	0.930	0.930	Yes
AHU-2	25	23.6	1718	0.923	0.930	Yes
AHU-3	7.5	6.6	1717	0.895	0.930	Yes
AHU-4	10	7.8	1775	0.895	0.930	Yes
AHU-5	7.5	4.6	1775	0.895	0.930	Yes
AHU-6	5	2.76	1711	0.875	0.930	Yes
SEF-1E	5	2.96	1246	0.875	0.930	Yes
SEF-2E	3	1.95	1844	0.875	0.930	Yes
SEF-3E	7.5	3.09	1085	0.895	0.930	Yes
SEF-4E	3	1.73	2378	0.875	0.930	Yes
RF-1E	15	7.06	876	0.900	0.930	Yes
RF-2E	15	7.73	1044	0.920	0.930	Yes

table-4

Appendix A

AHU-1													
Room		Actual						Calculated					
Number	Name	Service	cfm (max.)	cfm (min.)	OA cfm (max.)	OA cfm (min.)	A _z	Occupant Density	People	OA cfm rate	V _{bz} = V _{oz}	Z _p	
1226	Recording Control	TU 1-1	375	115	183.75	56.35	380	5	1.9	17	32.3	0.28	
1125	Writing Lab	TU 1-10	1650	495	808.5	242.55	1000	25	25	15	375	0.76	
1126	Writing Lab	TU 1-11	1600	480	784	235.2	1000	25	25	15	375	0.78	
1128	Bldg. Mgmt.	TU 1-12	200	60	98	29.4	400	5	2	17	34	0.57	
1206	Reception	TU 1-15	500	150	245	73.5	470	30	14.1	7	98.7	0.66	
1207	Kitchen	TU 1-16	175	55	85.75	26.95	150	20	3	11	33	0.60	
1258	Post Production B	TU 1-17	400	120	196	58.8	240	5	1.2	17	20.4	0.17	
1253	Studio B	TU 1-18A	1750	525	857.5	257.25	2125	25	53.125	10	531.25	1.01	
		TU 1-18B	1750	525	857.5	257.25	2125						
1243	Green Room	TU 1-19	150	45	73.5	22.05	130	5	0.65	17	11.05	0.25	
1224	Interview Studio	TU 1-2	650	195	318.5	95.55	615	5	3.075	17	52.275	0.27	
1244	Studio A	TU 1-21	2300	690	1127	338.1	865	25	21.625	10	216.25	0.31	
1240	Loading Dock	TU 1-22	250	75	122.5	36.75	855				102.6	168.6	2.25
1241	Staging						550				66		
1238	Prop Manuf.	TU 1-23	200	60	98	29.4	375				45	120	2.00
1239	Set Storage						625				75		
1236	Tape Vault	TU 1-24	100	30	49	14.7	510				61.2	2.04	
1235	Office	TU 1-25	100	30	49	14.7	160	5	0.8	17	13.6	0.45	
1234	Production Cont.	TU 1-26	375	115	183.75	56.35	355	5	1.775	17	30.175	0.26	
1232	Music Library	TU 1-27	125	40	61.25	19.6	400	5	2	17	34	0.85	
1230	Newsroom	TU 1-28	1500	450	735	220.5	845	5	4.225	17	71.825	0.16	
1275	Tech. Operations	TU 1-29	200	60	98	29.4	1580	5	7.9	17	134.3	2.24	
1223	Iso Booth	TU 1-3	175	55	85.75	26.95	130	5	0.65	17	11.05	0.20	
1271	Engineering	TU 1-30	350	105	171.5	51.45	585	5	2.925	17	49.725	0.47	
1272	Post Production A	TU 1-31	425	130	208.25	63.7	245	5	1.225	17	20.825	0.16	
1270	Field Download	TU 1-32	225	70	110.25	34.3	200	5	1	17	17	0.24	
1255	Audio B	TU 1-33	300	90	147	44.1	220	5	1.1	17	18.7	0.21	
1254	Control B	TU 1-34	875	265	428.75	129.85	620	5	3.1	17	52.7	0.20	
1252	Field Storage	TU 1-35	150	45	73.5	22.05	280				33.6	0.75	
1248	GSA Office	TU 1-36	250	75	122.5	36.75	190	4	0.76	16	12.16	28.31	0.38
1249	Office						190	5	0.95	17	16.15		
1246	Audio A	TU 1-38	600	180	294	88.2	180	5	0.9	17	15.3	0.09	
1245	Control A	TU 1-39	600	180	294	88.2	500	5	2.5	17	42.5	0.24	
1222	On-Air Control	TU 1-4	375	115	183.75	56.35	350	5	1.75	17	29.75	0.26	
1260	Post Equipment	TU 1-40	275	85	134.75	41.65	80				9.6	0.11	
1314	Unisex Toilet	TU 1-41	150	45	73.5	22.05	65				0	0.00	
1239	Set Storage	TU 1-42	200	60	98	29.4	625				0	0.00	
1216	Corridor	TU 1-43	200	60	98	29.4	500				30	48	0.80
1266	Corridor						300				18		

1208	Unisex Toilet	TU 1-44	100	30	49	14.7	65					0		0.00
1209	Unisex Toilet						65							
1251	Corridor	TU 1-45	200	60	98	29.4	450					27	57	0.95
1259	Corridor						500							
1228	Corridor	TU 1-46	250	75	122.5	36.75	650					39	60.6	0.81
1423	Corridor						360							
1221	News Booth	TU 1-5	200	60	98	29.4	120	5	0.6	17	10.2			0.17
1220	Edit A	TU 1-6	175	55	85.75	26.95	110	5	0.55	17	9.35			0.17
1219	Edit B	TU 1-7	175	55	85.75	26.95	95	5	0.475	17	8.075			0.15
1204	Conference	TU 1-9	400	120	196	58.8	320	50	16	6	96			0.80
$V_{ou} = 3,030 \text{ cfm}$														
$E_v = 0.152$														
$V_{ot} = 19,935 \text{ cfm}$														

AHU-2												
Room		Actual						Calculated				
Number	Name	Service	cfm (max.)	cfm (min.)	OA cfm (max.)	OA cfm (min.)	A _z	Occupant Density	People	OA cfm rate	V _{bz} = V _{oz}	Z _p
1101	Commons	TU 2-1A	1650	495	363	108.9	2385	5	11.925	17	202.725	0.10
		TU 2-1B	1650	495	363	108.9	2385					
		TU 2-1C	1650	495	363	108.9	2385					
		TU 2-1D	1650	495	363	108.9	2385					
1117	Women's RR	TU 2-2	150	45	33	9.9	275	5	1.575	17	0	0.00
1118	Men's RR						275				0	0.00
1105	Control Room	TU 2-3	2300	690	506	151.8	315	5	1.575	17	26.775	0.04
1108	Green Room	TU 2-4	175	55	38.5	12.1	140	5	0.7	17	11.9	0.22
1107	Auditorium	TU 2-5A	2350	705	517	155.1	2220	150	333	5	1665	2.36
		TU 2-5B	2350	705	517	155.1	2220					
1120	Conv. Room	TU 2-6	1375	415	302.5	91.3	910	5	4.55	17	77.35	0.19
1122	Editing Lab	TU 2-7	1300	390	286	85.8	750	5	3.75	17	63.75	0.16
1218	Newsroom	TU 2-8	325	100	71.5	22	320	5	1.6	17	27.2	0.27
1414	Shower	TU 2-9	150	45	33	9.9	75	5	1.6	17	0	0.00
1415	Shower						75				0	0.00
1412	Men's RR	TU 2-10	150	45	33	9.9	105	5	1.6	17	0	0.00
1413	Women's RR						105				0	0.00
2101	Commons	TU 2-1A	1650	495	363	108.9	2385	5	11.925	17	202.725	0.10
		TU 2-1B	1650	495	363	108.9	2385					
		TU 2-1C	1650	495	363	108.9	2385					
		TU 2-1D	1650	495	363	108.9	2385					
Vou = 2,300 cfm												
Ev = 0.80												
Vot = 2,875 cfm												

AHU-3											
Room		Actual			Calculated						
Number	Name	Service	OA cfm	A _z	Occupant Density	People	OA cfm rate	V _{bz} =V _{oz}			
2203	Corridor	TU 3-1	50	255				15.3			
2202	Classroom	TU 3-11	640	1000	65	65	8	520			
2204	Seminar Room	TU 3-12	480	660	65	42.9	8	343.2			
2212	Classroom	TU 3-13	820	1050	65	68.25	8	546			
2213	Classroom	TU 3-14	640	890	65	57.85	8	462.8			
2206	Men's RR	TU 3-15	40	115				0			
2207	Women's RR			115				0			
2211	Corridor	TU 3-2	750	500							30
3217	Classroom	TU 3-10	640	880				65	57.2	8	457.6
3206	Corridor	TU 3-3	1150	900				54			
3207	Men's RR	TU 3-4	120	115				0			
3208	Women's RR			115				0			
3210	Graduate Lab			140				25	3.5	15	52.5
3202	GIS Lab	TU 3-5	640	830	25	20.75	15	311.25			
3204	Seminar Room	TU 3-6	480	755	50	37.75	6	226.5			
3205	Research Lab	TU 3-7	140	460	5	2.3	17	39.1			
3212	Office	TU 3-8	180	90	5	0.45	17	7.65			
3213	CACS			380	5	1.9	17	32.3			
3215	Research Lab	TU 3-9	230	530	5	2.65	17	45.05			
3216	Office			90	5	0.45	17	7.65			
V _{ot} = 3,305 cfm											

AHU-4												
Room		Actual						Calculated				
Number	Name	Service	cfm (max.)	cfm (min.)	OA cfm (max.)	OA cfm (min.)	A _z	Occupant Density	People	OA cfm rate	V _{bz} = V _{oz}	
2117	Kitchenette	TU 4-1	300	300	300	300	155	20	3.1	11	34.1	
2105	Corridor	TU 4-2	200	200	200	200	610				36.6	43.8
2126	Corridor						120				7.2	
2107	Admin. Assistant	TU 4-33	160	160	160	160	175	5	0.875	17	14.875	53.13
2108	Advisor Office						150	5	0.75	17	12.75	
2109	Advisor Office						150	5	0.75	17	12.75	
2110	Advisor Office						150	5	0.75	17	12.75	
2111	Work Room	TU 4-34	140	140	140	140	150	5	0.75	17	12.75	57.25
2112	File Storage						300				36	
2113	Office						135	5	0.5	17	8.5	
2114	Women's RR	TU 4-35	315	315	315	315	100					
2115	Men's RR						100					
2116	Conference Room						320	50	21.5	6	129	
2103	Waiting	TU 4-36	120	120	120	120	430	30	12.9	7	90.3	
2104	Recept/Work											
2118	Advisor Office	TU 4-37	160	160	160	160	145	5	0.725	17	12.325	45.48
2119	Advisor Office						145	5	0.725	17	12.325	
2120	Advising Director						145	5	0.675	17	11.475	
2121	Admin. Assistant						135	5	0.55	17	9.35	
3101	Storage	TU 4-26	240	240	240	240	110				6.6	63.98
3102	Admin. Assistant						135	5	0.675	17	11.475	
3103	Office						135	5	0.675	17	11.475	
3104	Office						135	5	0.675	17	11.475	
3105	Work Room						135	5	0.675	17	11.475	
3113	Office						135	5	0.675	17	11.475	
3106	Corridor	TU 4-27	230	230	230	230	340				20.4	119.9
3107	Department Chair						195	5	0.975	17	16.575	
3108	Waiting						300	30	9	7	63	
3109	Recept/Work											
3110	Storage						70				8.4	
3111	Office						135	5	0.675	17	11.475	
3163	Office	TU 4-28	240	240	240	240	135	5	0.675	17	11.475	57.38
3164	Office						135	5	0.675	17	11.475	
3165	Office						135	5	0.675	17	11.475	
3166	Office						135	5	0.675	17	11.475	
3167	Office						135	5	0.675	17	11.475	
3158	Office	TU 4-29	220	220	220	220	135	5	0.675	17	11.475	57.38
3159	Office						135	5	0.675	17	11.475	
3160	Office						135	5	0.675	17	11.475	
3161	Office						135	5	0.675	17	11.475	
3162	Office						135	5	0.675	17	11.475	
3126	Conference Rm	TU 4-3	225	225	225	225	320	50	16	6	96	164.5
3127	Kitchenette						155	20	3.1	11	34.1	

3117	Office						135	5	0.675	17	11.475	
3118	Office						135	5	0.675	17	11.475	
3119	Office						135	5	0.675	17	11.475	
3120	Office	TU 4-31	300	300	300	300	135	5	0.675	17	11.475	58.23
3121	Office						135	5	0.675	17	11.475	
3122	Office						135	5	0.675	17	11.475	
3123	Library						280	5	1.4	17	23.8	
3124	Women's RR	TU 4-32	260	260	260	260	100					72.6
3125	Men's RR						100					
3128	Corridor						110				6.6	
3157	Corridor						1100				66	
4101	Storage	TU 4-17	240	240	240	240	110				13.2	70.58
4102	Director						135	5	0.675	17	11.475	
4103	Assitant						135	5	0.675	17	11.475	
4104	Graduate Director						135	5	0.675	17	11.475	
4105	Work Room						135	5	0.675	17	11.475	
4113	Office						135	5	0.675	17	11.475	
4106	Corridor	TU 4-18	230	230	230	230	360				21.6	101.2
4107	Department Chair						195	5	0.975	17	16.575	
4108	Waiting						150	30	4.5	7	31.5	
4109	Recept/Work						150	30	4.5	7	31.5	
4163	Office	TU 4-19	270	270	270	270	135	5	0.675	17	11.475	59.5
4164	Office						135	5	0.675	17	11.475	
4165	Office						135	5	0.675	17	11.475	
4166	Office						135	5	0.675	17	11.475	
4167	Office						160	5	0.8	17	13.6	
4158	Office	TU 4-20	230	230	230	230	135	5	0.675	17	11.475	57.38
4159	Office						135	5	0.675	17	11.475	
4160	Office						135	5	0.675	17	11.475	
4161	Office						135	5	0.675	17	11.475	
4162	Office						135	5	0.675	17	11.475	
4116	Elevator Lobby	TU 4-21	270	270	270	270	240				14.4	48.83
4117	Office						135	5	0.675	17	11.475	
4118	Office						135	5	0.675	17	11.475	
4119	Office						135	5	0.675	17	11.475	
4120	Office	TU 4-22	120	120	120	120	135	5	0.675	17	11.475	34.43
4121	Office						135	5	0.675	17	11.475	
4122	Office						135	5	0.675	17	11.475	
4123	Office	TU 4-23	255	255	255	255	270	5	1.35	17	22.95	
4124	Women's RR	TU 4-24	260	260	260	260	100					72.6
4125	Men's RR						100					
4126	Conference Room						285	50	14.25	6	85.5	
4128	Corridor	TU 4-5	220	220	220	220	110				6.6	72.6
4157	Corridor						1100				66	
4127	Kitchenette	TU 4-6	260	260	260	260	145	20	2.9	11	31.9	
5101	Assistant Dean	TU 4-10	205	205	205	205	180	5	0.9	17	15.3	48.88
5102	Assistant Dean						160	5	0.8	17	13.6	
5111	Work Room						135	5	0.675	17	11.475	
5112	Admin. Assistant						100	5	0.5	17	8.5	

5103	Corridor						200					12	
5104	Assistant Dean						120	5	0.6	17		10.2	
5105	Dean's Office						315	5	1.575	17		26.775	
5106	Devel. Officer	TU 4-11	290	290	290	290	165	5	0.825	17		14.025	192.5
5107	File Storage						90					10.8	
5109	Receipt/Work						365	30	10.95	7		76.65	
5110	Waiting						200	30	6	7		42	
5163	Dean's Conf.	TU 4-12	255	255	255	255	430	50	21.5	6		129	132
5164	Corridor						50					3	
5158	Office						135	5	0.675	17		11.475	
5159	Office						135	5	0.675	17		11.475	
5160	Office	TU 4-13	240	240	240	240	135	5	0.675	17		11.475	57.38
5161	Office						135	5	0.675	17		11.475	
5162	Office						135	5	0.675	17		11.475	
5116	Elevator Lobby						240					14.4	
5117	Office	TU 4-14	205	205	205	205	135	5	0.675	17		11.475	48.83
5118	Office						135	5	0.675	17		11.475	
5119	Office						135	5	0.675	17		11.475	
5120	Office						135	5	0.675	17		11.475	
5121	Office	TU 4-15	160	160	160	160	135	5	0.675	17		11.475	45.9
5122	Office						135	5	0.675	17		11.475	
5123	Office						135	5	0.675	17		11.475	
5124	Women's RR						100						
5125	Men's RR	TU 4-16	260	260	260	260	100						85.5
5126	Conference Room						285	50	14.25	6		85.5	
5127	Kitchenette	TU 4-7	260	260	260	260	110	20	2.2	11		24.2	
5113	Corridor						200					12	
5128	Corridor	TU 4-8	220	220	220	220	900					54	72.6
5157	Corridor						110					6.6	
5165	Kitchenette	TU 4-9	260	260	260	260	110	20	2.2	11		24.2	
V _{ot} = 2,365 cfm													

AHU-5												
Room		Actual						Calculated				
Number	Name	Service	cfm (max.)	cfm (min.)	OA cfm (max.)	OA cfm (min.)	A _z	Occupant Density	People	OA cfm rate	V _{bz} = V _{oz}	
1305	Office	TU 5-23	240	240	240	240	135	5	0.675	17	11.475	73.525
1306	Office						135	5	0.675	17	11.475	
1307	Office						135	5	0.675	17	11.475	
1308	Office						135	5	0.675	17	11.475	
1311	JMS Library						190	5	0.95	17	16.15	
1312	Office						135	5	0.675	17	11.475	
1301	Security Office	TU 5-24	100	100	100	100	110	5	0.55	17	9.35	37.4
1302	Office						110	5	0.55	17	9.35	
1303	Office						110	5	0.55	17	9.35	
1304	Office						110	5	0.55	17	9.35	
1261	Office	TU 5-25	200	200	200	200	135	5	0.675	17	11.475	56.95
1262	Office						135	5	0.675	17	11.475	
1263	Office						135	5	0.675	17	11.475	
1264	Office						135	5	0.675	17	11.475	
1265	Workroom						130	5	0.65	17	11.05	
1211	KUNV Gen. Man.	TU 5-26	360	360	360	360	165	5	0.825	17	14.025	112.625
1212	Office						135	5	0.675	17	11.475	
1213	Office						135	5	0.675	17	11.475	
1214	Office						135	5	0.675	17	11.475	
1217	Office						135	5	0.675	17	11.475	
1280	Office						140	5	0.7	17	11.9	
1281	Office						140	5	0.7	17	11.9	
1282	Office						140	5	0.7	17	11.9	
1283	UNLV-TV Man.						200	5	1	17	17	
2139	Office	TU 5-18	275	275	275	275	135	5	0.675	17	11.475	53.55
2140	Office						135	5	0.675	17	11.475	
2142	Office						135	5	0.75	17	12.75	
2143	Office						150	5	1.05	17	17.85	
2144	Department Chair	TU 5-19	190	190	190	190	210	5	0.425	17	7.225	21.675
2146	Corridor						85				5.1	
2147	Admin. Assistant						110	5	0.55	17	9.35	
2145	Corridor	TU 5-2	120	120	120	120	850				51	
2148	Waiting	TU 5-20	160	160	160	160	350	30	10.5	7	73.5	82.85
2149	Recept/Work						110	5	0.55	17	9.35	
2150	Work Room						150	5	0.75	17	12.75	
2134	Office	TU 5-21	240	240	240	240	150	5	0.75	17	12.75	51
2135	Office						150	5	0.75	17	12.75	
2136	Office						150	5	0.75	17	12.75	
2137	Office						150	5	0.75	17	12.75	
2130	Storage	TU 5-22	300	300	300	300	125				15	53.25
2131	Office						150	5	0.75	17	12.75	
2132	Office						150	5	0.75	17	12.75	
2133	Office						150	5	0.75	17	12.75	

3140	Office	TU 5-10	230	230	230	230	135	5	0.675	17	11.475	52.7
3142	Office						135	5	0.675	17	11.475	
3144	Department Chair						170	5	0.85	17	14.45	
3145	Admin. Assistant						90	5	0.45	17	7.65	
3146	Admin. Assistant						90	5	0.45	17	7.65	
3135	Office	TU 5-11	160	160	160	135	5	0.675	17	11.475	45.9	
3136	Office					135	5	0.675	17	11.475		
3137	Office					135	5	0.675	17	11.475		
3138	Office					135	5	0.675	17	11.475		
3147	Admin. Assistant	TU 5-12	200	200	200	110	5	0.55	17	9.35	108.8	
3148	Corridor					160				9.6		
3150	Waiting					215	30	6.45	7	45.15		
3151	Recept/Work.					150	30	4.5	7	31.5		
3152	Storage					110				13.2		
3131	Storage	TU 5-13	140	140	140	115				13.8	48.225	
3132	Office					135	5	0.675	17	11.475		
3133	Office					135	5	0.675	17	11.475		
3134	Office					135	5	0.675	17	11.475		
3149	Corridor	TU 5-3	120	120	120	120	740			44.4		
4149	Corridor	TU 5-4	120	120	120	120	740			44.4		
4135	Office	TU 5-6	160	160	160	135	5	0.675	17	11.475	45.9	
4136	Office					135	5	0.675	17	11.475		
4137	Office					135	5	0.675	17	11.475		
4138	Office					135	5	0.675	17	11.475		
4131	Storage	TU 5-7	140	140	140	135				8.1	42.525	
4132	Office					135	5	0.675	17	11.475		
4133	Office					135	5	0.675	17	11.475		
4134	Office					135	5	0.675	17	11.475		
4140	Office	TU 5-8	215	215	215	135	5	0.675	17	11.475	59.5	
4142	Office					135	5	0.675	17	11.475		
4144	Department Chair					160	5	0.8	17	13.6		
4145	Admin. Assistant					135	5	0.675	17	11.475		
4146	Admin. Assistant					135	5	0.675	17	11.475		
4147	Admin. Assistant	TU 5-9	200	200	200	135	5	0.675	17	11.475	94.925	
4148	Corridor					80				4.8		
4150	Waiting					165	30	4.95	7	34.65		
4151	Recept/Work					165	30	4.95	7	34.65		
4152	Work Room					110	5	0.55	17	9.35		
5135	Office	TU 5-14	160	160	160	135	5	0.675	17	11.475	45.9	
5136	Office					135	5	0.675	17	11.475		
5137	Office					135	5	0.675	17	11.475		
5138	Office					135	5	0.675	17	11.475		
5131	Storage	TU 5-15	140	140	140	110				13.2	47.625	
5132	Office					135	5	0.675	17	11.475		
5133	Office					135	5	0.675	17	11.475		
5134	Office					135	5	0.675	17	11.475		
5140	Office	TU 5-16	260	260	260	135	5	0.675	17	11.475	57.375	
5142	Office					135	5	0.675	17	11.475		
5144	Department Chair					165	5	0.825	17	14.025		

5145	Admin. Assistant						120	5	0.6	17	10.2	
5146	Admin. Assistant						120	5	0.6	17	10.2	
5147	Corridor						80				4.8	
5149	Waiting						165	30	4.95	7	34.65	
5150	Recept/Work	TU 5-17	210	210	210	210	165	30	4.95	7	34.65	94.925
5151	Work Room						110	5	0.55	17	9.35	
5152	Work Room						135	5	0.675	17	11.475	
5148	Corridor	TU 5-5	120	120	120	120	740				44.4	
$V_{ot} = 1,500 \text{ cfm}$												